Published in final edited form as:

Prehosp Emerg Care. 2014 ; 18(3): 402–407. doi:10.3109/10903127.2014.891065.

Motor Vehicle Crash Severity Estimations by Physicians and Prehospital Personnel

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Abstract

Objective—To determine whether emergency physicians (EPs) and prehospital emergency medical services (EMS) personnel differ in their assessment of motor vehicle crash (MVC) severity and the potential for serious injury when viewing crash scene photographs.

Methods—Attending and resident EPs, paramedics, and emergency medical technicians (EMTs) from a single emergency medicine system used a web-based survey platform to rate the severity of 100 crash photographs on a 10-point Likert scale (Crash Score) and the potential for serious injury on a 0–100% scale (Injury Score). Serious injury was defined as skull fracture or intracranial bleeding, spine fracture or spinal cord injury, intrathoracic or intraabdominal injury, or long bone fracture. Crash and Injury Scores were stratified into EP and paramedic/EMT (EMS) groups and the mean score was calculated for each photo. Spearman rank correlation coefficients with 95% confidence intervals (95% CI) and Bland-Altman plots were constructed to assess agreement. Secondary analyses were performed after categorizing data into quartiles based on participants' estimations of MVC severity.

Results—A total of 54 attending and 53 resident EPs, 156 paramedics, and 34 EMTs were invited to participate in the survey. Of these, 39 (72%) attending and 46 (87%) resident EPs, 107 (69%) paramedics, and 17 (50%) EMTs completed the survey. A total of 183 (88%) surveys were completed in full. The overall Crash Score correlation coefficient between EPs and EMS was 0.98 (95% CI, 0.97–0.99). The Crash Score correlation coefficients for each quartile were 0.86 (0.57–0.97), 0.93 (0.85–0.96), 0.58 (0.16–0.85), and 0.88 (0.66–0.97), respectively. The overall Injury Score correlation coefficient between EPs and EMS was 0.98 (0.88–0.97). The Injury Score

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Presented, in part, at the Research Forum of the American College of Emergency Physicians Scientific Assembly in Las Vegas, Nevada, September 28, 2010.

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Supplementary Material Available Online

Appendix Figure 1: Motor vehicle crash severity survey instrument.

Supplementary material can be viewed and downloaded at <http://informahealthcare.com/pec>

correlation coefficients for each quartile were 0.94 (0.48–0.91), 0.76 (0.50–0.92), 0.80 (0.69–1.00), and 0.94 (0.57–0.97), respectively.

Conclusion—Although overall agreement between EPs and EMS personnel was excellent, differences in estimation of crash severity and potential for injury were identified among crashes estimated to be moderate in severity.

Keywords

emergency medical services (EMS); motor vehicle; accidents; wounds and injuries

Introduction

Motor vehicle collisions (MVCs) constitute a large number of ambulance responses in most emergency medical services (EMS) systems. Prehospital personnel are responsible for transporting victims of MVCs to local emergency departments (EDs), where a description of the crash mechanism and severity comprises part of the report to physicians. Traditionally, the vehicle speed, location of primary impact, and vehicular damage are described and the collision is often categorized by prehospital personnel as a low-, moderate-, or high-energy mechanism. There is good evidence that MVC mechanism and vehicular damage are associated with severity of injury.^{1–4}

Prehospital personnel, however, are sometimes unable to accurately predict the severity of injury in patients they are transporting.^{5–8} Previous studies have shown that crash photographs do not correlate with descriptions of vehicle damage as given in written reports and that EMS reports often provide inadequate descriptions of crash variables.⁹ In addition, the presence of crash photographs significantly alters the physician's perception of crash severity and subsequent management, and physicians are likely to rate the crash as more severe than the verbal report indicated.¹⁰

The estimation of crash severity often influences prehospital and ED triage and evaluation of crash victims. It is unclear whether physicians and prehospital personnel reliably agree on this estimation. A description of this agreement, or lack thereof, may impact the way in which crash severity is estimated and patients are triaged and evaluated after MVCs. Therefore, the goal of this study was to determine whether emergency physicians (EPs) and EMS personnel differ in their assessment of MVC severity and the potential for serious injury when viewing crash scene photographs.

Methods

Study Design, Setting, and Population

We performed a prospective, cross-sectional survey of attending and resident EPs, paramedics, and emergency medical technicians (EMTs) from a single urban EMS system. The study site was a large, urban, tertiary care and teaching hospital with its own EMS division in Denver, Colorado. Denver Health Medical Center is a level I trauma center with an annual ED volume of approximately 75,000 visits and the Denver Health Paramedic Division serves as the primary EMS provider for Denver County, responding to

approximately 85,000 EMS 9-1-1 calls and transporting approximately 55,000 patients annually. MVCs comprise approximately 7% of all calls in this system and 60% of MVCs are transported to the hospital. All personnel within the system were asked to voluntarily participate and informed consent was provided. The study protocol was approved by the Colorado Multiple Institutional Review Board.

Survey Design, Administration, and Measurements

One hundred crash scene photographs, selected from various Internet sources, were identified to represent a broad range of mechanism and severity as determined by four experienced emergency physicians. No specific information about outcomes of the patients involved in the MVCs depicted in photographs was known. No patients were visible in the photographs. A total of 54 attending and 53 resident EPs, 156 paramedics, and 34 EMTs were invited to participate in the survey. A web-based survey platform (Zoomerang.com, Market-Tools, Palo Alto, California) was used and respondents were asked to log in to the website, provide informed consent, and enter the following information: age, sex, occupation, and cumulative number of years in the emergency medicine field. Participants then viewed each crash scene photograph and were asked to rate the severity of the crash (Crash Score) on a 10-point Likert scale and the potential for serious injury (Injury Score) on an 11-point 0–100% scale (Appendix Figure 1, available online). Serious injury was defined for the participants as skull fracture or intracranial hemorrhage, spine fracture or spinal cord injury, intrathoracic or intraabdominal injury, or long bone fracture. The MVC victim was assumed to be an otherwise-healthy restrained driver in the car pictured. Scoring was performed on each photograph prior to viewing the next photograph in the series. If more than one car was pictured in the photograph, the car of interest was specifically stated in the survey. Participants received no special training on crash severity rating or on the survey platform prior to completing the survey.

Data Management and Statistical Analyses

Data were transferred into and all analyses performed using SAS Version 9.2 (SAS Institute, Cary, NC). Crash and Injury Scores were stratified into EP and paramedic/EMT (EMS) groups and both mean and median scores were calculated for each photo. Given the slight nonnormality of the aggregated crash and injury scores, we used Spearman rank correlation coefficients with 95% confidence intervals (CIs) to assess correlation between the two groups of participants. Additional correlations were calculated, and planned a priori, by quartiles of participants' estimations of MVC severity, recognizing that correlation possibly differed within the estimated range of crash or injury severity (e.g., less correlation in the middle than compared to either end of the spectrum). Given the ordinal nature of the data, we also calculated agreement using weighted kappa with 95% CIs. Finally, Bland-Altman plots were constructed to further characterize agreement between the two groups. Partially completed surveys were included in the data analysis as long as the participant completed a minimum of 10% of the survey questions. No a priori sample size was calculated.

Results

Of all invited participants, 39 (72%) attending and 46 (87%) resident EPs, 107 (69%) paramedics, and 17 (50%) EMTs completed the survey. Of these, 183 (88%) surveys were completed in full (Table 1). Descriptive statistics, including age, sex, and years of experience, are reported in Table 2. The overall Crash Score correlation coefficient and weighted kappa between EPs and EMS were 0.98 (95% CI: 0.97–0.99) and 0.91 (95% CI: 0.89–0.95), respectively (Figure 1). The Crash Score correlation coefficients for each quartile were 0.86 (95% CI: 0.57–0.97), 0.93 (95% CI: 0.85–0.96), 0.58 (95% CI: 0.16–0.85), and 0.88 (95% CI: 0.66–0.97), respectively. The overall Injury Score correlation coefficient and weighted kappa between EPs and EMS were 0.98 (95% CI: 0.88–0.97) and 0.87 (95% CI: 0.84–0.92), respectively (Figure 2). The Injury Score correlation coefficients for each quartile were 0.94 (95% CI: 0.48–0.91), 0.76 (95% CI: 0.50–0.92), 0.80 (95% CI: 0.69–1.00), and 0.94 (95% CI: 0.57–0.97), respectively. Bland-Altman plots for both the Crash Score and Injury Score are shown in Figures 3 and 4, respectively, and demonstrate a qualitatively higher estimation of crash and injury severity by EPs when compared to EMS personnel.

Discussion

Accurate, timely, and complete transmission of data is an important element for appropriate evaluation and treatment of patients. In the case of MVCs, in most EMS systems, this information is communicated between EMS personnel and EPs at hand-off via verbal or written reports. Crash mechanism, including speed, location of impact, and passenger compartment damage, provides insight into the patient's potential for serious injury.¹⁰ Since we know EPs modify their evaluation of MVC victims when provided with a crash scene photograph in addition to verbal or written reports, it may be implied that differences in crash severity estimations influence subsequent ED care.¹¹ Presumably, a more accurate representation of crash severity and mechanism will improve the EP's ability to care for patients.

The goal of our study was to assess agreement between EMS personnel and EPs with regard to estimations of crash severity and potential for injury following MVCs. Lerner et al. have shown that certain elements of vehicular damage are moderate predictors of trauma center need.¹⁰ Other studies, however, have found that estimations of vehicle damage are less predictive of resource use.¹² However, since Dickinson et al. have shown that physicians change their behavior when provided with additional crash scene information, it is assumed that any differences in these estimations may affect the communication of crash variables between EMS and EPs at hand-off and may affect the triage, diagnosis, and management of MVC victims.¹⁰ Previous studies have attempted to determine the accuracy of EMS estimations of crash severity and potential for injury.^{13,14} EMS personnel are relatively accurate predictors of crash severity and vehicular damage when compared to professional crash reconstructionists.¹³ To our knowledge, there has only been one small study investigating the accuracy of EP estimations of crash severity.¹⁵ Our study, on the other hand, focuses on the agreement of the two parties involved in this communication. EMS and EPs rarely both get to view a crash scene and, therefore, the communication of crash scene

severity and potential for serious injury depends, to some degree, on their *estimations* of severity. If EMS and EPs do not agree on these estimations, then there is potential for miscommunication at this hand-off.

We found excellent crash and injury agreement at both ends of the severity spectrum but only modest agreement, and therefore greater variability, in the middle of the severity spectrum. Moreover, a qualitative assessment of the scatterplots as well as the Bland-Altman plots suggests that EPs provide, in general, higher estimations of crash severity when compared to their EMS counterparts; these differences appear to be greatest when mechanism is estimated to be “moderate.” Further investigation is needed to determine the magnitude of these differences and whether they impact patient care. Future areas of research might focus on ways of communicating crash scene information directly without relying on providers’ judgment of the crash severity and potential for injury.

Limitations

Our study is limited by the fact that it was performed within a single EMS and hospital system. Our results may not generalize to the broader EMS community. In addition, the design of our study may have inadvertently limited our ability to detect a difference in MVC severity estimations. We intentionally included photographs of a wide range of crash severities that ranged from extremely minor (paint scraped on a bumper) to extremely major (destroyed car). We found very tight correlation between EP and EMS ratings of severity on either end of the severity spectrum and this influenced our overall finding of excellent agreement between the two groups. However, Bland and Altman have pointed out that wide sample spreads will often lead to a high correlation and that this should not always be interpreted as representing close agreement.¹⁶ This limitation was mitigated by construction of the Bland-Altman plots. Finally, there are some limitations inherent to the survey instrument itself. Because we know nothing about the outcome of the victims of the crashes pictured, we have no way of knowing whether the photographs accurately reflect the true crash mechanism. Furthermore, when differences did exist between EPs and EMS, we have no way of identifying which participants were the more accurate estimators of crash mechanism. The survey was relatively long and “survey fatigue” may have influenced scores, especially toward the end of the survey. There was no way to randomize the order of photographs from survey to survey in order to ameliorate this potential confounder.

Conclusion

Although overall agreement between EPs and EMS personnel was excellent, only modest agreement was identified among crash mechanisms estimated to be moderate in severity. Additionally, EPs appear to estimate higher probabilities of crash and injury severity than EMS personnel.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Supported, in part, by K02 HS017526 and R01 AI106057 to Dr. Haukoos.

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Figure 1.
Mean crash score among emergency physicians (EP) vs. mean crash score among emergency medical services personnel (EMT).

Figure 2.
Mean injury score among emergency physicians (EP) vs. mean injury score among emergency medical services personnel (EMT).

Figure 3. Bland-Altman plot comparing crash score between emergency physicians and emergency medical services personnel. Score difference was calculated as emergency physician score minus emergency medical technician or paramedic score.

FIGURE 4.

Bland-Altman plot comparing injury score between emergency physicians and emergency medical services personnel. Score difference was calculated as emergency physician score minus emergency medical technician or paramedic score.

Table 1

Participation by invited subjects

	Invited	Participated	Completed
Attending EP	54	39 (72%)	31 (57%)
Resident EP	53	46 (87%)	41 (77%)
Paramedic	156	107 (69%)	96 (62%)
EMT	34	17 (50%)	15 (44%)

EP, emergency physician; EMT, emergency medical technician.

Table 2

Description of participating subjects

	Attending EP	Resident EP	Paramedic	EMT
Male	25 (64%)	25 (54%)	80 (75%)	9 (60%)
Age (yrs)				
21–30	0 (0%)	29 (63%)	28 (26%)	0 (0%)
31–40	15 (38%)	17 (37%)	57 (53%)	12 (71%)
41–50	12 (31%)	0 (0%)	18 (17%)	3 (18%)
51–60	7 (18%)	0 (0%)	4 (4%)	2 (12%)
61–70	4 (10%)	0 (0%)	0 (0%)	0 (0%)
Experience (yrs)				
<1	0 (0%)	10 (22%)	0 (0%)	4 (24%)
1–5	2 (5%)	30 (65%)	14 (13%)	6 (35%)
6–10	9 (23%)	6 (13%)	31 (29%)	3 (18%)
11–15	6 (15%)	0 (0%)	30 (28%)	1 (6%)
16–20	9 (23%)	0 (0%)	17 (16%)	1 (6%)
21–25	4 (10%)	0 (0%)	9 (8%)	0 (0%)
>25	8 (21%)	0 (0%)	6 (6%)	2 (12%)

EP, emergency physician; EMT, emergency medical technician.